Figure 4-3 Detrital Wash downstream of White Hills Road

Figure 4-4 Detrital Wash Grouted Riprap Protection North side of White Hills Road

Figure 4-5 White Hills Road Looking East

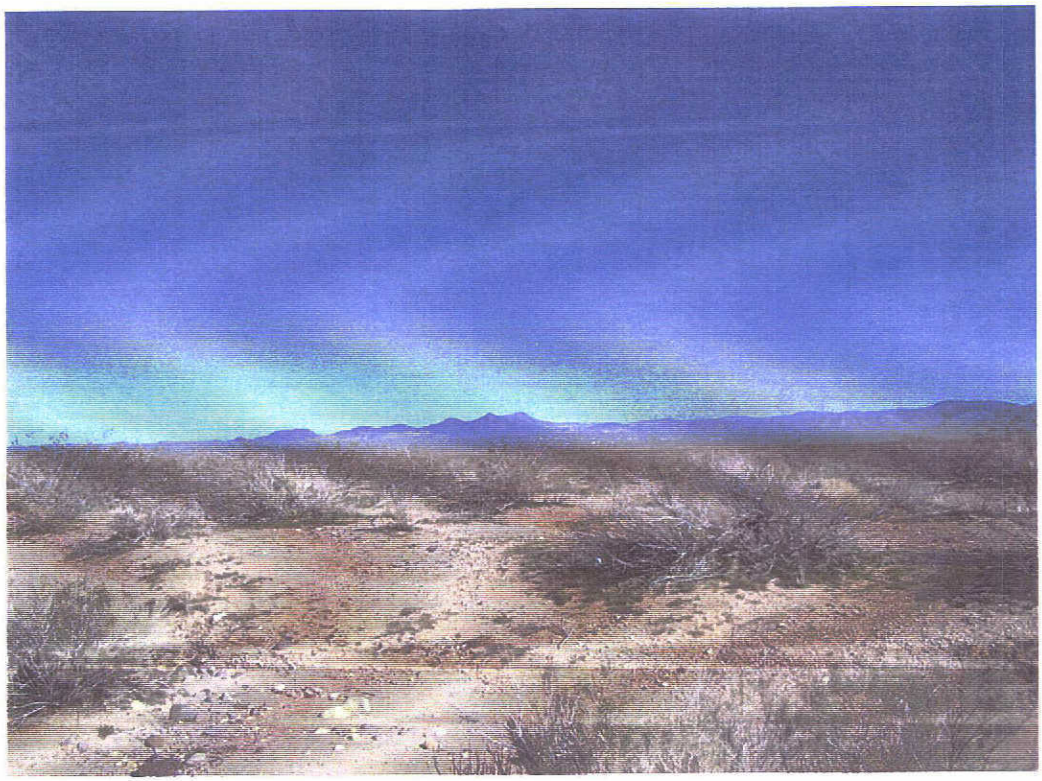

Figure 4-6 White Hills Panorama No. 1

CL00980

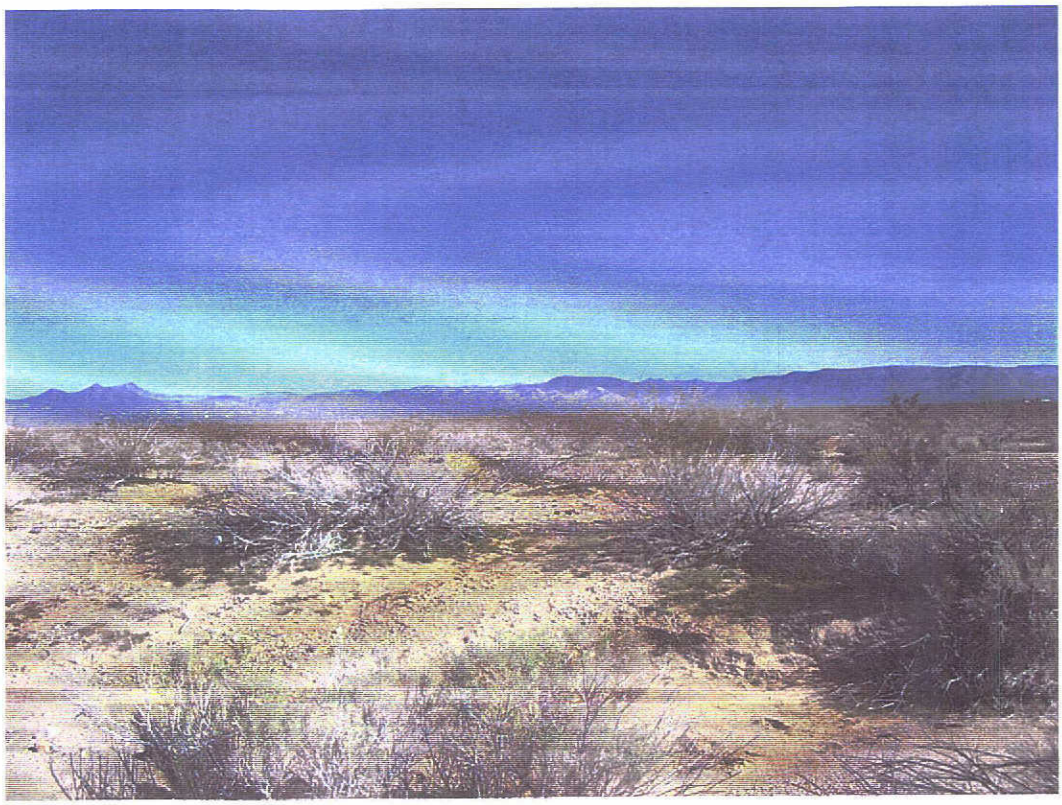

Figure 4-7 White Hills Panorama No. 2

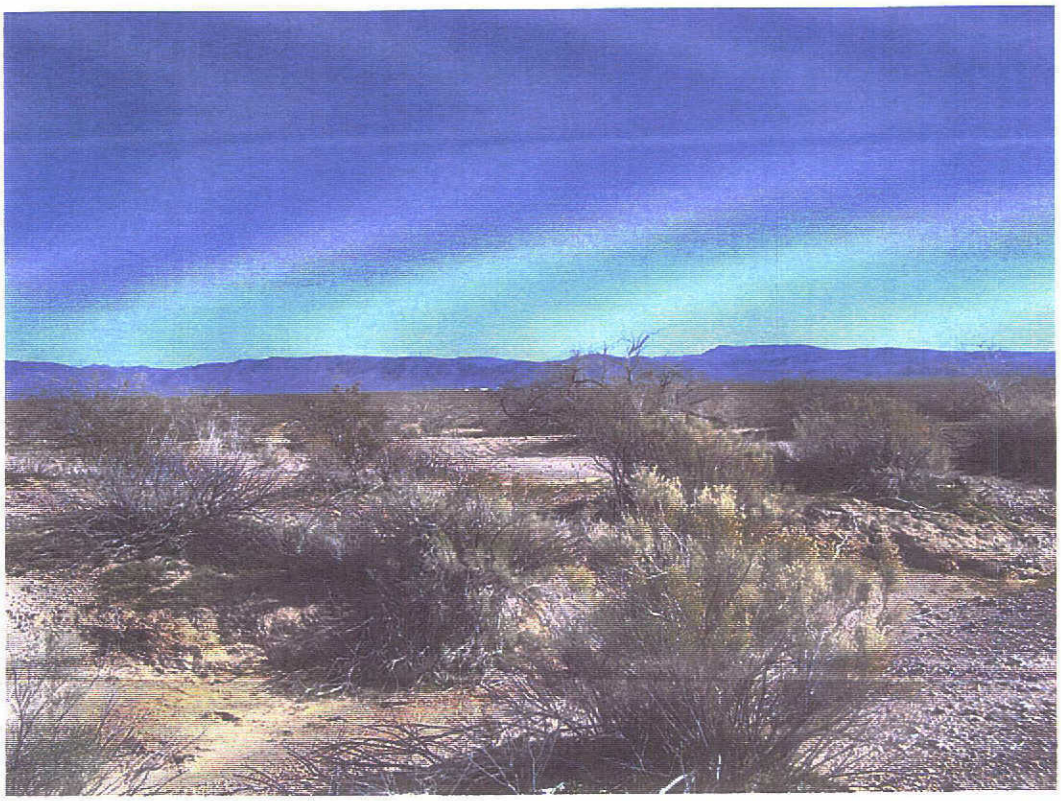

Figure 4-8 White Hills Panorama No. 3

CL00981

Drainage Descriptions

The watershed area is located between the Black Mountains and the White Hills with the Detrital Valley in between. The Detrital Wash lies along the valley floor and flows northward, crossing White Hills Road at a flat 0.58 percent grade. An alluvial fan extends from the White Hills to the Detrital Wash sloping westerly with fan slopes ranging between 1.7 and 2.1 percent. The White Hills Road intersects U.S. Highway 93 at the site and forms an elevated drainage barrier as it extends in a northeasterly direction into the White Hills (Figure 4-1 *Vicinity Map & Drainage Basin Boundary*).

The existing drainage facilities within the area consist of a multi culvert crossing for flows from the Detrital Wash crossing White Hills Road near the west side of the site. The Detrital Wash is allowed to overtop the White Hills Road in major storms. The upstream and downstream shoulders are protected by a concrete apron. Low flows are conveyed across the road through (6) 36-inch CMP pipes that are mitered to the upstream slope and project out of slope downstream. Some under cutting is evident just downstream of the concrete apron. Grouted riprap was added to the northeast roadside swale to control erosion. Current culvert capacity under White Hills Road is approximately 380 cfs. All other flows will weir over the roadway. Preliminary estimates calculate the 100-year; 24-hour flows to be approximately 54,000 cfs.

Other drainage related structures include a culvert crossing under U.S. Highway 93 (size unknown) entering the site from the west (Drainage Shed WHD1) and road side ditches paralleling White Hills Road. White Hills Road intercepts minor runoff from the hills and conveys it in a southwesterly direction to Detrital Wash. The capacity of the southerly ditch varies with slope and depth. As runoff reached the ditch's capacity, 100 cfs in areas, it will overtop and spill across the roadway. The northerly ditch receives pavement runoff and releases it to the north toward Detrital Wash via multiple release points along the route. Major runoff flow overtops the crest of the road and continues to flow in a northwesterly direction. Near the two-thirds point of White Hills Road, a major wash crosses the road via an at-grade crossing. It continues in a northwesterly direction, entering the Detrital Wash northwest of the project.

The White Hills Mountains contain Type 7 Soils while the remainder of the valley consists of Type 4. Soil Types are summarized in Table 4-1.

Table 4-1 - Soil Types

Map Symbol	Association Name	Description	HSG
4	Anthony-Vinton-Agua	35% Sandy loam or gravelly sandy loam on 0 to 5 percent slopes 30% Loamy sand on 0 to 5 percent slopes 20% Loam on 0 to 2 percent slopes	B
7	Cellar-House Mountain-Rock Outcrop	35% Very gravelly sandy loam on 5 to 45 percent slopes 25% Cobbly loam on 15 to 60 percent slopes 20% Rock Outcrop on steep slopes	D

HYDROLOGY

Hydrologic Method and Criteria

The U.S. Army Corps of Engineers' HEC-1 Flood Hydrograph Package and the State of Arizona, DOT's Hydrology Manual was used to estimate the peak runoff values of the watershed for the 100-year, 6-hour and 24-hour storm events. The 6-hour storm event or "local storm" is used to evaluate runoff generated within specific drainage sheds less than 100 square miles. The 100-yr, 24-hr "regional store" is used to develop runoff over larger shed areas. The Drainage Design Management System for Windows (DDMSW) developed for Maricopa County, AZ is used as a tool to develop input parameters and runoff hydrographs for the HEC-1 program. It uses local soil and hydrologic data to generate a data file for input into the HEC-1 program. Precipitation values for the White Hills site is taken from the NOAA Atlas 2, Volume VIII and is summarized for the values used in DDMSW program in Table 4-2. DDMSW also applies area-depth reduction factors to account for the varying rainfall as the storm looses intensity away from the storm center. The HEC-1 model simulates flood events in watersheds and river basins and models precipitation runoff response of a drainage basin by representing the basin as an interconnected system of hydrologic and hydraulic components. Each component models an aspect of the rainfall-runoff process within a portion of the whole basin. This basin portion is referred to as a sub-basin. The runoff hydrographs of each sub-basin are then combined and a final discharge hydrograph is obtained.

Table 4-2 - Rainfall Data

Duration	2-yr Point Value	100-yr Point Value
6 Hr	1.2	3.0
24 Hr	1.4	3.8

The entire watershed is approximately 396 square miles.

Model Results

Existing Conditions

Runoff flow for each drainage sub-shed and points of flow concentration are identified as they enter the project site along its boundary. These are evaluated to identify impact to the site and propose mitigating measures. Locations of these points for the existing site conditions (undeveloped) are shown on Figure 4-10 *Major Channel Improvements*. Table 4-3 presents the results for existing conditions from the HEC-1 analysis for this study. Runoff flows are generated from 100-yr, 6-hr rainfall parameters for sheds under 100 square miles as they enter the site from the south, east, and west. The larger flow associated directly with the Detrital Wash is evaluated for "regional" precipitation having a drainage shed area greater than 100 square miles.

Table 4-3 – Existing Conditions Flow Summary

DRAINAGE SHEDS			DRAINAGE JUNCTIONS		
Drainage Shed	Area (sq miles)	Runoff (cfs)	Drainage Shed	Area (sq miles))	Runoff (cfs)
WHB	94.7	12767[1]	WHD15	0.45	1260
WHC	179.18	37227[1]	WHD16	0.06	189
WHD1	7.01	3792	WHD17	0.11	346
WHD2	59.83	10527[1]	WHD18	0.22	605
WHD3	29.44	6051	WHD19	1.95	1168
WHD4	9.02	1875	WHD21	0.38	197
WHD5	2.78	1905	JWHD6	4.05	2457
WHD6	1.27	984	JWHD8	0.79	614
WHD7	0.46	598	JWHD9	22.05	11621
WHD8	.32	598	JWHD10	30.1	6065
WHD9	1.95	2821	JWHD11	30.81	6042
WHD10	0.66	917	JWHD12	30.23	6094
WHD11	1.36	477	JWHD13	13.04	3834
WHD12	0.78	816	JWHD21	30.48	6048
WHD13	3.18	3008	JDW1	273.88	37664[1]
WHD14	2.23	1875	JDW2	363.15	54162[1]

1 Flow based on 100-yr, 24 hr precipitation

HYDRAULICS

Hydraulic analysis was performed on the proposed conveyance structures that will transport runoff from drainage sheds outside of the project boundaries, across the site to the its natural point of release. FlowMaster V.7.0 by Haestad Methods Inc. is a program that uses the Manning Equation to evaluate hydraulic properties.

Criteria for the channel analysis limit the maximum velocity within a concrete channel to 30 ft/sec. Energy dissipation is required where channels exit into the wash or into a detention structure.

SUMMARY

The development proposed for the White Hills site will consist of residential and non residential land uses. The site will consist of approximately 2,162 acres of residential developments and approximately 2,727 acres of non-residential uses, including commercial, parks and roadways.

As previously discussed the approximated runoff of the Detrital Wash at White Hills Road is 54,000 cfs. To completely pass all of the 100-year flow under White Hills Road, a series of (31) 20-foot by 10-foot RCBs would be needed. To replace the Detrital Wash with a concrete lined channel would require a trapezoidal channel with 2:1 side slopes, 425-foot bottom width, 8.5 feet deep. The major wash crossing White Hills Road (3,800

cfs, upstream of White Hills Road) is proposed to be conveyed in a concrete channel within its natural alignment. The channel is estimated to have a 20-foot bottom width across Section 21 and a 54-foot bottom width across Section 17. A series of (5) 12- foot by 8-foot CB's would be needed to pass the flow under White Hills Road.

The 100-year flow from the White Hills area is approximately 6,100 cfs (at the alluvial fan apex). Since runoff from an alluvial fan can shift across the fan with each storm, any proposed facilities intercepting westerly flows along the easterly perimeter should accommodate the entire fan runoff flow for safely purposes.

Stormwater from off-site sheds will be conveyed through the projects via internal street conveyance or concrete lined channels. Runoff within a street section is limited to a maximum of 8-inches deep. Stormwater in excess of the street capacity will travel in concrete trapezoidal channels, having a maximum allowable velocity of 30 feet per second. Channels with potential velocity in excess of 30 ft/sec will be controlled using strategically placed drop structures.

Hydraulic analyses were performed to evaluate conveyance channels for several drainage improvement scenarios. The scenario recommended provides a drainage cutoff channel to divert apex runoff from the project (see Figure 4-10 *Major Channel Improvements*). The location of the channel is along the southern boundary of Section 20, the easterly half of Section 21, along the northern boundary of Section 28 (Bureau of Land Management), and along the easterly boundary of Section 30. The channel continues in a westerly direction to White Hills Road, then parallel with White Hills Road to the Detrital Wash. The cutoff channel protects the project from large flows from the alluvial fan.

STORM DRAIN FACILITIES

The storm drainage facilities were estimated using the current Land Use Plan and are based on the assumption that the recommended cutoff channel is installed. No storm drainage detention basins are proposed to reduce run-on flow. They will be required to reduce developed (on-site) runoff flow to pre development conditions. Table 4-4 summarizes construction costs for these storm drainage improvements.

Table 4-4 Drainage Construction Cost Summary

Facility	Quantity	Cost
On-site Conveyance - Channel Improvements	64,100	$ 31,466,300
Detention Basins	Lump sum	$ 995,300
Detrital Wash – Channel Improvements	1,300 lf	$ 7,458,800
Detrital Crossing – 20'x 10' RCG Culverts	Lump sum	$ 2,791,700
White Hills Road Crossing – 12'x8' RCB Culverts	Lump sum	$ 920,800
Sub Total		$ 43,632,700
Contingency (25%)		$ 10,908,200
Total		$ 54,540,900

It should be noted that the southeast third of Section 23 is located along the steep hill side of the White Hills range. Slopes in this area are in excess of 30 percent. Storm drainage facilities require special consideration for public safety and erosion issues.

REFERENCES

1) *Flood Insurance Rate Map*, Community Panel Number 040058 1600 B, Mohave County, Arizona, effective March 15, 1982

2) *Highway Drainage Design Manual*, Arizona Department of Transportation, Report Number FHWA-AZ93-281, Final Report, March, 1993

3) *Drainage Design Manual for Maricopa County, Arizona*, Hydrology: Rainfall, Flood Control District of Maricopa County, November 2003

4) *Drainage Design Management System*, Users Manual, Flood Control District of Maricopa County